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Addition to the Ephemeris for Physical Observations of Jupiter. On the Motion of the White Spot. By A. Marth, Esq.

Next to the great reddish spot, of which observations have been made since the autumn of 1878, the small white spot, a little south of *Jupiter's* equator, which seems to have first attracted attention in the autumn of 1880, promises, by its long continued visibility, to be of special service in the study of the changes which are going on upon the surface of *Jupiter*. The variations in the rate of motion and in the brightness of the spot render careful and assiduously continued observations of its position and of its appearance essential for any further investigations. In order to enable readers to see how far the known observations of the spot can be represented on the assumption of regular motion, I give a list of all the observed passages of the spot across the middle of the disk, which have come to my knowledge, together with the corresponding longitudes in a system in which the daily rate of rotation is assumed to be $=878°.46$. These longitudes are connected with the system of longitudes adopted in the ephemeris by the equation

$$\text{Corresponding long.} = \text{Long. of } \mathcal{U}\text{'s Central Meridian} + \text{Corr. for phase} + 336°.0 + 8°.04\,(t - t_0),$$

in which t is the time of the observed passage, and $t_0 =$ Aug. 2, 1882, 0^h Gr. The period of rotation corresponding to the daily rate $878°.46$ is $9^h\ 50^m\ 7^s.42$, while that corresponding to the assumed rate of rotation of the First Meridian is $9^h\ 55^m\ 34^s.47$.

The history of the development of the spot before Oct. 16,

1880, requires clearing up, and I must leave it, for the present, an open question whether the earlier observations refer really to the same object. The observations of Kortazzi are found in the *Bulletin de l'Acad. de St.-Pétersbourg*, tome 27, p. 142, those of Schmidt in No. 2353 of the *Astron. Nachrichten*; the others are taken from papers in the *Monthly Notices*, letters in the *English Mechanic*, or from private communications. The places of observing and the apertures of the instruments employed are:—

Barnard; Nashville, Tennessee; 5 in. refractor.

Corder; Writtle, near Chelmsford; 4·5 in. reflector.

Dennett; Southampton; 9·5 in. reflector.

Denning; Bristol; 10 in. reflector.

Kortazzi; Nicolajew; 6·5 in. refractor.

McCance; Putney; 10 in. reflector.

Schmidt; Athens; 6·5 in. dialyt.

A. S. Williams; West Brighton; 5·2 in. reflector and 2·7 in. refractor.

In the case of Schmidt's observations, two values of the resulting longitudes are given, the first corresponding to the time of the observed passage as directly observed, the second to the time after applying the correction which Schmidt himself has deduced, and about which I must content myself with referring to his paper. The abbreviations are: Ath. Athens, Gr. Greenwich, Nic. Nicolajew, b. bright, f. faint, v. very.

Observed Time of Passage.				Observer.	Corr. Long.	
					°	
1880, Aug. 27	11 18·7	Nic.		Kortazzi	17·7	
Sept. 5	11 34·0	„		„	14·2	
7	12 43·1	„		„	13·6	
16	13 0·5	„		„	11·4	
18	11 50	Gr.	vb	Denning	3·7	
21	10 58·1	Nic.		Kortazzi	9·8	
Oct. 16	10 51·4	Ath.		Schmidt	30·6	30·3
18	12 2·3	„		„	31·0	29·9
19	7 36·8	„		„	27·7	27·3
20	11 38	Gr.	vb	Denning	31·2	
21	8 46·6	Ath.		Schmidt	27·3	27·2
23	9 52·8	„		„	24·8	24·7
28	7 56·1	„		„	26·3	26·2
29	11 53·3	Gr.		Williams	27·4	
30	7 25	„		Corder	22·3	
30	7 28	„	vb	Denning	24·1	
30	9 4·6	Ath.		Schmidt	25·1	25·1

Observed Time of Passage.				Observer.	Corr. Long.	
1880, Nov. 2	14 15	Gr.	b	Denning	28°0	
3	9 47	„	b	„	23·0	
4	5 25	„	b	„	21·6	
4	7 3·0	Ath.		Schmidt	23·5	23·3
6	8 12·0	„		„	22·6	22·6
8	7 48	Gr.		Denning	22·8	
8	9 23·4	Ath.		Schmidt	23·2	22·8
9	5 4·9	„		„	23·9	22·8
11	6 20·1	„		„	26·8	26·5
12	11 54·6	„		„	29·3	25·9
15	8 38·6	„		„	24·1	23·9
17	8 14	Gr.		Denning	24·9	
17	8 15	„		Corder	25·5	
17	8 15	„		Williams	25·5	
17	8 15·5	„		Dennett	25.8	
17	9 52·0	Ath.		Schmidt	26·8	25·7
19	9 20	Gr.		Corder	22·1	
19	9 23	„	vb	Denning	23·9	
19	9 26·5	„		Dennett	25·8	
19	9 28	„		McCance	27·0	
20	5 0	„		Corder	21·9	
20	5 2	„	vb	Denning	23·1	
21	10 35	„		McCance	24·7	
21	10 41	„	b	Denning	28·4	
22	6 15	„		McCance	30·6	
22	6 18	„		Corder	32·4	
22	16 4·2	„		Barnard	23·9	
26	8 40	„		McCance	26·6	
26	8 44	„	vf	Denning	29·1	
27	4 19	„	vb	„	25·8	
27	4 21	„		Williams	27·1	
28	9 51	„	vb	Denning	26·8	
29	5 27	„	vb	„	24·1	
Dec. 2	12 14·0	„		Barnard	27·6	
3	7 54	„	f	Denning	27·4	
6	14 36·2	„		Barnard	27·8	
10	7 14	„	vb	Denning	31·5	
12	8 27	„	vb	„	32·8	
15	5 16	„	vb	„	31·3	

Observed Time of Passage.				Observer.	Corr. Long.
					°
1880, Dec. 21	8 48	Gr.		McCance	30·6
21	8 49	,,		Denning	31·2
23	10 4	,,	vb	,,	33·6
24	5 36·5	,,		McCance	28·7
25	11 17	,,		Williams	34·7
28	7 59	,,	vb	Denning	28·8
30	9 11	,,		McCance	29·4
30	9 15	,,	vb	Denning	31·8
31	4 47	,,		McCance	27·6
1881, Jan. 6	8 26·5	,,		,,	30·2
6	8 27	,,	b	Denning	30·5
7	4 5	,,	f	,,	29·0
7	4 6	,,		McCance	29·6
13	7 37	,,	vvb	Denning	27·8
15	8 53	,,		Williams	30·7
16	4 28	,,	vb	Denning	27·4
Feb. 23	7 5	,,	f	,,	15·6
July 10	14 45	,,	vb	,,	16·4
17	13 56	,,	vb	,,	15·0
24	13 7	,,	vf	,,	13·8
26	14 19	,,	b	,,	14·5
Aug. 2	13 36	,,	b	,,	17·1
4	14 47	,,	b	,,	17·2
8	17 8	,,	f	,,	16·9
17	17 31	,,	vb	,,	16·9
18	13 12	,,	b	,,	17·2
27	13 33	,,	vvb	,,	16·3
Sept. 1	11 38	,,	f	,,	18·6
7	15 13	,,	f	,,	20·7
9	16 26	,,		Williams	22·3
15	10 10:	,,	f	Denning	23·9
15	10 10·5	,,		Williams	24·3
16	15 33	,,		,,	19·5
19	12 9	,,	vvb	Denning	16·8
21	13 30	,,	vvb	,,	17·2
25	15 46	,,		Williams	14·3
26	11 26·5	,,		,,	14·6
27	16 46	,,		,,	8·0
28	12 40	,,	b	Denning	16·5

Observed Time of Passage.				Observer.	Corr. Long.
1881, Sept. 30	13 52	Gr.	vf	Denning	17°5
Oct. 3	10 49	„	vvf	„	21·6
5	12 3	„	vb	„	23·9
11	15 36	„		Williams	25·3
17	9 13	„	vb	Denning	29·1
25	13 58	„	vb	„	25·7
25	13 58·5	„		Williams	26·0
26	9 36	„		„	24·5
28	10 44	„		Denning	23·2
30	11 52·5	„		Williams	22·2
30	11 54	„	vb	Denning	23·1
Nov. 6	11 6	„		Williams	24·0
7	16 37	„		„	24·5
14	5 56	„	b	Denning	23·6
15	11 32	„	vb	„	27·2
22	10 44	„	f	„	28·0
22	10 47·5	„	vf	Williams	30·1
23	6 25	„	vf	Denning	28·5
23	6 26	„	vf	Williams	29·2
23	16 16	„	vf	Denning	29·1
27	8 45	„	b	„	28·2
27	8 55	„		Corder	34·3
28	4 27	„	vb	Denning	29·4
28	14 18	„	b	Williams	29·9
29	9 52	„	vvb	Denning	26·2
29	9 54·5	„	b	Williams	27·7
Dec. 1	11 55	„	b	„	28·4
2	6 44	„	vvb	Denning	27·2
3	12 14	„	vvb	„	27·0
7	4 41	„	vvb	„	24·7
7	4 45	„		Corder	27·1
7	14 33	„	vb	Denning	25·8
8	10 20	„		Corder	30·0
10	11 26	„	vb	Denning	27·3
12	12 30	„		Williams	23·4
13	8 12	„	vvb	Denning	24·5
13	8 12	„	vf	Williams	24·5
18	6 12	„	b	Denning	23·7
20	7 26	„	b	„	25·7

Observed Time of Passage.				Observer.	Corr. Long.
1881, Dec. 21	12 54	Gr.	b	Williams	24°3
22	8 33	„	vvb	Denning	23·5
23	4 11	„	vvb	„	22·2
24	9 43	„	vb	„	23·2
24	9 44	„	vf	Williams	23·8
29	7 50	„		Corder	26·4
1882, Jan. 3	5 44	„	vf	Denning	21·6
5	7 5	„	vvf	„	27·8
6	12 34	„	vvf	„	26·9
7	8 13	„	f	„	26·1
9	9 27	„	b	„	28·0
10	5 8	„	vb	„	28·4
13	11 52	„	vvb	„	29·9
16	8 42	„	vvb	„	29·1
21	6 38	„	b	„	25·2
Feb. 1	8 22	„	f	„	30·2
3	9 32	„	vb	Williams	29·5
8	7 38	„	f	Denning	31·4
10	8 50	„	b	Williams	31·9
12	10 0	„	f	Denning	31·1
13	5 43	„	f	„	32·4
17	8 7	„	vf	„	33·5
19	9 23	„	vvf	„	36·5
19	9 23	„	vf	Williams	36·5
21	10 33	„	f	Denning	35·6
26	8 34	„	vvb	„	34·3
Mar. 3	6 30	„	vvb	„	29·9
12	6 59	„	vvb	„	31·7
14	8 5	„	b	„	28·4
14	8 12	„	vvb	Williams	32·6
16	9 19	„	vvb	Denning	29·9
16	9 21	„	b	Williams	31·1
30	7 41	„	vf	Denning	25·5
Apr. 6	7 1	„	vvb	„	28·3
8	8 12	„	b	„	28·0
July 29	15 49	„	vb	„	29·8
Aug. 5	15 4	„	vb	„	30·8
7	16 9	„	vb	„	27·1

In case the white spot should remain visible and keep approxi-

mately its mean rate of motion, it may be looked for near the central meridian at the times which follow or precede the predicted passages of the First Meridian, given on pp. 391–95, by the interval indicated in the following table:—

1882.				1883.						h		
Aug. 26	Oct. 10	Nov. 24	Jan. 7	Feb. 21	Apr. 7	6	*after*	F. Mer.
30	14	28	12	26	11	5	„	„
Sept. 4	19	Dec. 3	16	Mar. 2	16	4	„	„
9	23	7	21	7	20	3	„	„
13	28	12	25	11	25	2	„	„
18	Nov. 1	16	30	16	29	1	„	„
22	6	21	Feb. 3	20	May 4	0	„	„
27	10	25	8	25	9	1	*before*	„
Oct. 1	15	30	12	29	13	2	„	„
6	19	Jan. 3	17	Apr. 3	18	3	„	„
10	24	8	21	7	22	4	„	„
15	28	12	26	12	27	5	„	„

Cannot some of the many possessors of sufficiently powerful telescopes be induced to take part in the interesting observations of *Jupiter's* spots?

Ephemerides of the Satellites of Saturn, December 1882, *to March* 1883. By A. Marth, Esq.

The following ephemerides of the five inner satellites are a continuation of those published in the last number of the *Monthly Notices*, so that it will be sufficient to refer to the explanations there given.

The ascending node N and inclination J of the plane of the ring in reference to the plane of the Earth's equator are here assumed to be

1882, Nov. 30	N = 126°·4545	J = 7°·0148
Dec. 30	·4590	·0144
1883, Jan. 29	·4621	·0140
Feb. 28	·4639	·0136
Mar 30	126·4661	7·0134

The assumed longitudes of the satellites in their orbits are (*v.* page 396)—

0^h Gr.	*Mimas.*	*Enceladus.*	*Tethys.*	*Dione.*	*Rhea.*
1882, Nov. 30	312°·116	168°·269	193°·801	208°·167	352°·737
Dec. 30	251·839	130·225	154·746	194·219	223·442
1883, Jan. 29	191·562	92·182	115·691	180·270	94·147
Feb. 28	131·287	54·139	76·635	166·322	324·851
Mar. 30	71·012	16·095	37·579	152·373	195·555

0^h Gr.	P	L	Latitude of Earth above plane of ring.	Latitude of Sun above plane of ring.	A−L
1882.					
Nov. 30	358°·264	50°·263	−22°·651	−23°·286	+1°·822
Dec. 5	358·313	49·870	22·578	23·329	2·409
10	358·359	49·500	22·512	23·372	2·972
15	358·402	49·160	22·453	23·415	3·506
20	358·441	48·853	22·402	23·458	4·007
25	358·475	48·584	22·361	23·500	4·471
30	358·503	48·355	22·330	23·542	4·894
1883.					
Jan. 4	358·526	48·169	−22·310	−23·583	+5·274
9	358·544	48·030	22·302	23·624	5·609
14	358·556	47·940	22·305	23·666	5·894
19	358·561	47·898	22·320	23·707	6·130
24	358·560	47·905	22·347	23·747	6·318
29	358·552	47·961	22·385	23·788	6·457
Feb. 3	358·539	48·066	−22·435	−23·828	+6·547
8	358·520	48·220	22·495	23·868	6·589
13	358·494	48·421	22·566	23·908	6·584
18	358·463	48·668	22·646	23·948	6·533
23	358·426	48·959	22·735	23·987	6·438
28	358·384	49·292	22·832	24·026	6·301
Mar. 5	358·337	49·666	−22·936	−24·065	+6·123
10	358·285	50·079	23·047	24·104	5·907
15	358·228	50·528	23·163	24·142	5·654
20	358·167	51·010	23·284	24·180	5·368
25	358·103	51·523	23·409	24·218	5·051
30	358·035	52·067	−23·536	−24·256	+4·706

	Diam. of Ball			Axis of Ring		*Mimas.*			
0^h Gr.	Equat.	Phase. foll. l.	Polar.	Major.	Minor.	a_1	b_1	l_1-L	Diff.
1882.	"	"	"	"	"	"	"	°	°
Nov. 30	19·88	0·005	18·20	45·83	17·65	31·26	−12·04	263·45	1910·29
Dec. 5	19·81	·007	18·14	45·67	17·54	31·16	11·96	13·74	·25
10	19·73	·013	18·06	45·48	17·41	31·04	11·88	123·99	·20
15	19·63	·019	17·97	45·25	17·28	30·87	11·79	234·19	·15
20	19·51	·024	17·86	44·99	17·14	30·69	11·69	344·34	·10
25	19·39	·030	17·74	44·69	17·00	30·49	11·60	94·44	·05
30	19·25	·035	17·62	44·38	16·86	30·27	11·50	204·49	1910·00
1883.									
Jan. 4	19·10	·040	17·48	44·04	16·72	30·04	−11·40	314·49	1909·94
9	18·95	·045	17·34	43·68	16·58	29·79	11·31	64·43	·88
14	18·79	·050	17·19	43·31	16·44	29·54	11·21	174·31	·83
19	18·62	·053	17·04	42·93	16·30	29·28	11·12	284·14	·77
24	18·46	·056	16·89	42·54	16·18	29·02	11·03	33·91	·72
29	18·29	·058	16·74	42·16	16·05	28·76	10·95	143·63	·67
Feb. 3	18·12	·059	16·58	41·77	15·94	28·49	−10·87	253·30	1909·62
8	17·95	·059	16·43	41·39	15·84	28·23	10·80	2·92	·57
13	17·80	·059	16·29	41·01	15·74	27·98	10·74	112·49	·53
18	17·63	·057	16·14	40·65	15·65	27·73	10·68	222·02	·48
23	17·48	·055	16·00	40·29	15·57	27·48	10·62	331·50	·44
28	17·33	·052	15·87	39·95	15·50	27·25	10·57	80·94	·41
Mar. 5	17·19	·049	15·74	39·62	15·44	27·03	−10·53	190·35	1909·38
10	17·05	·045	15·62	39·31	15·39	26·82	10·50	299·73	·35
15	16·93	·041	15·51	39·02	15·35	26·62	10·47	49·08	·32
20	16·81	·037	15·40	38·75	15·32	26·43	10·45	158·40	·30
25	16·70	·034	15·30	38·49	15·29	26·26	10·43	267·70	1909·28
30	16·60	0·028	15·21	38·26	15·28	26·10	−10·42	16·98	

	Enceladus.				*Tethys.*			
0^h Gr.	a_2	b_2	l_2-L	Diff.	a_3	b_3	l_3-L	Diff.
1882.	"	"	°	°	"	"	°	°
Nov. 30	40·10	−15·44	119·11	1314·01	49·64	−19·12	144·34	953·85
Dec. 5	39·97	15·35	353·12	1313·97	49·48	19·00	18·19	·82
10	39·80	15·24	227·09	·94	49·27	18·86	252·01	·79
15	39·60	15·12	91·03	·89	49·02	18·72	124·80	·74
20	39·37	15·00	334·92	·85	48·73	18·57	359·54	·71
25	39·11	14·88	208·77	·80	48·42	18·42	233·25	·66
30	38·83	14·75	82·57	·74	48·07	18·26	106·91	·60

Enceladus.

0^h Gr.	a_2	b_2	l_2—L	Diff.
1883.	″	″	°	°
Jan. 4	38·54	−14·63	316·31	1313·70
9	38·22	14·51	190·01	·64
14	37·90	14·39	63·65	·58
19	37·57	14·27	297·23	·53
24	37·23	14·16	170·76	·48
29	36·89	14·05	44·24	·43
Feb. 3	36·55	−13·95	277·67	1313·38
8	36·22	13·86	151·05	·33
13	35·89	13·77	24·38	·29
18	35·57	13·70	257·67	·25
23	35·26	13·63	130·92	·20
28	34·96	13·57	4·12	·17
Mar. 5	34·67	−13·51	237·29	1313·14
10	34·40	13·47	110·43	·10
15	34·15	13·43	343·53	·07
20	33·91	13·40	216·60	·05
25	33·68	13·38	89·65	1313·03
30	33·48	−13·37	322·68	

Tethys.

a_3	b_3	l_3—L	Diff.
″	″	°	°
47·70	−18·11	340·51	953·54
47·32	17·96	214·05	·50
46·91	17·81	87·55	·45
46·50	17·66	321·00	·40
46·09	17·52	194·40	·35
45·67	17·39	67·75	·30
45·25	−17·27	301·05	953·25
44·83	17·15	174·30	·19
44·43	17·05	47·49	·15
44·03	16·95	280·64	·11
43·65	16·87	153·75	·07
43·28	16·79	26·82	·03
42·92	−16·73	259·85	953·00
42·59	16·67	132·85	952·96
42·27	16·63	5·81	·93
41·97	16·59	238·74	·91
41·70	16·57	111·65	952·88
41·44	−16·55	344·53	

Dione.

0^h Gr.	a_4	b_4	l_4—L	Diff.
1882.	″	″	°	°
Nov. 30	63·58	−24·49	158·46	658·05
Dec. 5	63·37	24·33	96·51	658·01
10	63·10	24·16	34·52	657·98
15	62·78	23·98	332·50	·94
20	62·41	23·79	270·44	·91
25	62·01	23·59	208·35	·86
30	61·57	23·39	146·21	·81
1883.				
Jan. 4	61·10	−23·19	84·02	657·77
9	60·60	23·00	21·79	·71
14	60·09	22·81	319·50	·66
19	59·56	22·62	257·16	·61
24	59·03	22·44	194·77	·55
29	58·49	22·27	132·32	·51

Rhea.

a_5	b_5	l_5—L	Diff.
″	″	°	°
88·79	−34·19	302·81	398·83
88·49	33·98	341·64	·80
88·12	33·74	20·44	·77
87·67	33·48	59·21	·74
87·16	33·22	97·95	·70
86·59	32·95	136·65	·65
85·98	32·67	175·30	·60
85·32	−32·39	213·90	398·56
84·63	32·12	252·46	·51
83·91	31·85	290·97	·46
83·18	31·59	329·43	·41
82·43	31·34	7·84	·35
81·68	31·11	46·19	·31

		Dione.				*Rhea.*			
0^h Gr.		a_4	b_4	l_4-L	Diff.	a_5	b_5	l_5-L	Diff.
1883.		″	″	°	°	″	″	°	°
Feb.	3	57·95	−22·12	69·83	657·46	80·93	−30·89	84·50	398·26
	8	57·42	21·97	7·29	·41	80·19	30·68	122·76	·21
	13	56·90	21·84	304·70	·36	79·46	30·50	160·97	·17
	18	56·39	21·71	242·06	·32	78·75	30·32	199·14	·12
	23	55·90	21·60	179·38	·29	78·07	30·17	237·26	·08
	28	55·43	21·51	116·67	·24	77·41	30·04	275·34	·04
Mar.	5	54·98	−21·42	53·91	657·21	76·77	−29·92	313·38	398·00
	10	54·55	21·35	351·12	·17	76·17	29·82	351·38	397·97
	15	54·14	21·30	288·29	·14	75·60	29·74	29·35	·94
	20	53·76	21·25	225·43	·11	75·07	29·68	67·29	·91
	25	53·41	21·22	162·54	657·09	74·58	29·63	105·20	397·88
	30	53·08	−21·20	99·63		74·13	−29·60	143·08	

Approximate Greenwich Mean Times of conjunctions of the satellites with the centre of *Saturn*:
"n" inferior conj., north; "s" superior conj., south.

1882.	h		1882.	h		1882.	h	
Nov. 30	17·2	Rh. s.	Dec. 5	10·4	Mi. n.	Dec. 9	17·7	Di. s.
Dec. 1	3·1	Te. s.		15·2	Di. n.		17·8	Rh. s.
	12·7	Di. s.		17·1	En. n.	10	12·1	En. s.
	14·4	En. n.		20·4	Te. n.		13·6	Te. s.
	16·0	Mi. n.	6	9·1	Mi. n.		14·8	Mi. s.
2	1·8	Te. n.		9·5	En. s.	11	2·5	Di. n.
	6·9	En. s.		19·0	Te. s.		4·6	En. n.
	14·6	Mi. n.	7	0·1	Di. s.		12·2	Te. n.
	21·6	Di. n.		1·9	En. n.		13·4	Mi. s.
	23·4	Rh. n.		7·7	Mi. n.	12	0·0	Rh. n.
3	0·4	Te. s.		11·7	Rh. n.		10·9	Te. s.
	13·2	Mi. n.		17·6	Te. n.		11·4	Di. s.
	15·7	En. s.	8	6·3	Mi. n.		12·1	Mi. s.
	23·1	Te. n.		8·9	Di. n.		13·4	En. n.
4	6·4	Di. s.		10·8	En. n.	13	5·9	En. s.
	8·2	En. n.		16·3	Te. s.		9·5	Te. n.
	11·8	Mi. n.	9	3·3	En. s.		10·7	Mi. s.
	21·7	Te. s.		4·9	Mi. n.		20·2	Di. n.
5	0·6	En. s.		14·9	Te. n.	14	6·2	Rh. s.
	5·5	Rh. s.		16·2	Mi. s.		8·2	Te. s.

1882.	h		1882.	h		1883.	h	
Dec. 14	9·3	Mi. s.	Dec. 27	13·2	Te. s.	Jan. 5	12·8	Mi. n.
	14·8	En. s.		13·9	Mi. s.		12·9	En. s.
15	5·0	Di. s.		15·1	En. n.		20·0	Rh. s.
	6·8	Te. n.		19·2	Rh. s.		23·7	Te. s.
	7·2	En. n.	28	7·6	En. s.	6	2·3	Di. s.
	7·9	Mi. s.		11·9	Te. n.		5·3	En. n.
16	5·5	Te. s.		12·5	Mi. s.		11·4	Mi. n.
	6·5	Mi. s.		21·3	Di. s.		22·4	Te. n.
	12·3	Rh. n.	29	10·5	Te. s.	7	10·0	Mi. n.
	13·8	Di. n.		11·1	Mi. s.		11·2	Di. n.
	16·1	En. n.		16·5	En. s.		14·2	En. n.
17	4·1	Te. n.	30	1·4	Rh. n.		21·1	Te. s.
	5·1	Mi. s.		6·2	Di. n.	8	2·2	Rh. n.
	8·5	En. s.		8·9	En. n.		6·6	En. s.
	22·7	Di. s.		9·2	Te. n.		8·6	Mi. n.
18	2·8	Te. s.		9·8	Mi. s.		19·7	Te. n.
	18·5	Rh. s.	31	1·3	En. s.		20·0	Di. s.
19	1·4	Te. n.		7·8	Te. s.	9	7·3	Mi. n.
	7·5	Di. n.		8·4	Mi. s.		15·5	En. s.
	9·8	En. n.		1·50	Di. s.		18·4	Te. s.
20	0·1	Te. s.		1·78	En. n.	10	4·9	Di. n.
	16·3	Di. s.	1883.				5·9	Mi. n.
	22·7	Te. n.	Jan. 1	6·5	Te. n.		8·0	En. n.
21	0·7	Rh. n.		7·0	Mi. s.		8·4	Rh. s.
	21·3	Te. s.		7·6	Rh. s.		17·0	Te. n.
22	1·2	Di. n.		10·2	En. s.	11	4·5	Mi. n.
	20·0	Te. n.		23·8	Di. n.		13·7	Di. s.
23	6·9	Rh. s.	2	2·7	En. n.		15·7	Te. s.
	10·0	Di. s.		5·1	Te. s.		15·8	Mi. s.
	18·6	Te. s.		5·6	Mi. s.		16·8	En. n.
24	17·3	Te. n.	3	3·8	Te. n.	12	9·3	En. s.
	18·8	Di. n.		4·2	Mi. s.		14·3	Te. n.
25	13·0	Rh. n.		8·7	Di. s.		14·4	Mi. s.
	13·8	En. s.		11·5	En. n.		14·6	Rh. n.
	15·9	Te. s.		13·8	Rh. n.		22·5	Di. n.
26	3·7	Di. s.	4	2·4	Te. s.	13	1·7	En. n.
	6·2	En. n.		4·0	En. s.		13·0	Te. s.
	14·6	Te. n.		14·2	Mi. n.		13·0	Mi. s.
	15·3	Mi. s.		17·5	Di. n.		18·2	En. s.
27	12·5	Di. n.	5	1·1	Te. n.	14	7·4	Di. s.

1883.	h		
Jan. 14	10·6	En.	n.
	11·6	Te.	n.
	11·7	Mi.	s.
	20·8	Rh.	s.
15	3·1	En.	s.
	10·3	Te.	s.
	10·3	Mi.	s.
	16·2	Di.	n.
16	8·9	Mi.	s.
	8·9	Te.	n.
	12·0	En.	s.
17	1·1	Di.	s.
	3·0	Rh.	n.
	7·6	Te.	s.
18	6·2	Te.	n.
	9·9	Di.	n.
19	4·9	Te.	n.
	9·2	Rh.	s.
	18·8	Di.	s.
20	3·6	Te.	n.
	14·6	En.	s.
21	2·2	Te.	s.
	3·6	Di.	n.
	7·1	En.	n.
	15·4	Rh.	n.
22	0·9	Te.	n.
	12·5	Di.	s.
	23·5	Te.	s.
23	8·4	En.	s.
	10·6	Mi.	n.
	21·3	Di.	n.
	21·6	Rh.	s.
	22·2	Te.	n.
24	0·8	En.	n.
	9·2	Mi.	n.
	17·3	En.	s.
	20·8	Te.	s.
25	6·2	Di.	s.
	7·8	Mi.	n.
	9·7	En.	n.

1883.	h		
Jan. 25	19·5	Te.	n.
26	2·2	En.	s.
	3·9	Rh.	n.
	6·4	Mi.	n.
	15·0	Di.	n.
	18·2	Te.	s.
27	5·0	Mi.	n.
	11·1	En.	s.
	16·8	Te.	n.
	23·8	Di.	s.
28	3·5	En.	n.
	3·7	Mi.	n.
	10·1	Rh.	s.
	15·0	Mi.	s.
	15·5	Te.	s.
29	8·7	Di.	n.
	12·4	En.	n.
	13·6	Mi.	s.
	14·1	Te.	n.
30	4·8	En.	s.
	12·2	Mi.	s.
	12·8	Te.	s.
	16·3	Rh.	n.
	17·5	Di.	s.
31	10·8	Mi.	s.
	11·4	Te.	n.
	13·7	En.	s.
Feb. 1	2·4	Di.	n.
	6·2	En.	n.
	9·5	Mi.	s.
	10·1	Te.	s.
	22·5	Rh.	s.
2	8·1	Mi.	s.
	8·8	Te.	n.
	11·3	Di.	s.
	15·1	En.	n.
3	6·7	Mi.	s.
	7·4	Te.	s.
	7·5	En.	s.
	20·1	Di.	n.

1883.	h		
Feb. 4	4·8	Rh.	n.
	5·3	Mi.	s.
	6·1	Te.	n.
	16·4	En.	s.
5	4·0	Mi.	s.
	4·7	Te.	s.
	5·0	Di.	s.
	8·9	En.	n.
6	1·3	En.	s.
	3·4	Te.	n.
	11·0	Rh.	s.
	13·8	Di.	n.
	13·9	Mi.	n.
7	2·1	Te.	s.
	10·2	En.	s.
	12·5	Mi.	n.
	22·7	Di.	s.
8	0·7	Te.	n.
	2·6	En.	n.
	11·1	Mi.	n.
	17·2	Rh.	n.
	19·1	En.	s.
	23·4	Te.	s.
9	7·5	Di.	n.
	9·7	Mi.	n.
	11·5	En.	n.
	22·0	Te.	n.
10	4·0	En.	s.
	8·4	Mi.	n.
	16·4	Di.	s.
	20·7	Te.	s.
	23·5	Rh.	s.
11	7·0	Mi.	n.
	12·9	En.	s.
	19·4	Te.	n.
12	1·2	Di.	n.
	5·3	En.	n.
	5·6	Mi.	n.
	18·0	Te.	s.
13	5·7	Rh.	n.

1883.	h			1883.	h			1883.	h		
Feb.	13	10·1	Di. s.	Feb.	27	20·6	Te. s.	Mar.	14	15·1	Rh. s.
		16·7	Te. n.		28	11·6	Di. n.			23·3	Te. s.
	14	6·7	En. s.			19·3	Te. n.		15	13·1	Di. s.
		15·3	Te. s.	Mar.	1	1·5	Rh. s.			21·9	Te. n.
		18·9	Di. n.			17·9	Te. s.		16	20·6	Te. s.
	15	12·0	Rh. s.			20·4	Di. s.			21·4	Rh. n.
		14·0	Te. n.		2	16·6	Te. n.			22·0	Di. n.
	16	3·8	Di. s.		3	5·3	Di. n.		17	19·3	Te. n.
		12·7	Te. s.			7·8	Rh. n.		18	6·8	Di. s.
	17	11·3	Te. n.			15·3	Te. s.			17·9	Te. s.
		12·7	Di. n.		4	13·9	Te. n.		19	3·7	Rh. s.
		18·2	Rh. n.			14·2	Di. s.			15·7	Di. n.
	18	10·0	Te. s.		5	12·6	Te. s.			1·66	Te. n.
		21·5	Di. s.			14·1	Rh. s.		20	0·6	Di. s.
	19	8·6	Te. n.			23·0	Di. n.			15·3	Te. s.
	20	0·5	Rh. s.		6	11·3	Te. n.		21	10·0	Rh. n.
		6·4	Di. n.		7	7·9	Di. s.			13·9	Te. n.
		7·3	Te. s.			9·9	Te. s.		22	9·4	Di. n.
	21	6·0	Te. s.			20·3	Rh. n.			12·6	Te. s.
		15·2	Di. n.		8	8·6	Te. n.		23	11·3	Te. n.
	22	4·6	Te. s.			16·8	Di. n.			16·3	Rh. s.
		6·7	Rh. n.		9	7·3	Te. s.			18·3	Di. n.
	23	0·1	Di. n.		10	1·6	Di. s.		24	9·9	Te. s.
		3·3	Te. n.			2·6	Rh. s.		25	3·2	Di. n.
	24	2·0	Te. s.			5·9	Te. n.			8·6	Te. n.
		9·0	Di. s.		11	4·6	Te. s.			22·5	Rh. n.
		13·0	Rh. s.			10·5	Di. n.		26	7·3	Te. s.
	25	0·6	Te. n.		12	3·3	Te. n.			12·1	Di. s.
		17·8	Di. n.			8·9	Rh. n.		27	5·9	Te. n.
		23·3	Te. s.			19·4	Di. s.			20·9	Di. n.
	26	19·3	Rh. n.		13	1·9	Te. s.		28	4·6	Te. s.
		22·0	Te. n.		14	0·6	Te. n.			4·8	Rh. s.
	27	2·7	Di. s.			4·2	Di. n.				

By means of this list of conjunctions and of the little table given on page 404, approximate places of the satellites may be easily found for any hour, as the table gives the coordinates of the satellites at intervals of an hour, reckoned from the time of the nearest (preceding or following) conjunction with the centre. Observers who are desirous to follow the motions of the satellites will do well to lay down the data of the table graphically on a

sufficiently large scale, so that by marking the corresponding times for the night of observing they may get information about the places of the satellites at a glance. The places change in the direction of decreasing position-angles.

The following ephemerides of *Titan* and *Iapetus* give the positions of the two satellites in reference to the circle of declination.

Differences of Right Ascension and Declination between Titan and Iapetus, and the Centre of Saturn.

	Titan.		*Iapetus.*	
0^h Gr.	$\alpha-A$	$\delta-D$	$\alpha-A$	$\delta-D$
	s	"	s	"
1882, Nov. 30	+14·25	+19·6	+25·79	+225·8
Dec. 1	+12·12	+46·4	23·20	224·6
2	+ 8·15	+66·1	20·48	222·1
3	+ 2·90	+75·3	17·64	218·2
4	− 2·80	+72·3	14·69	213·1
5	− 8·02	+57·4	11·66	206·6
6	−11·89	+32·8	8·56	198·9
7	−13·76	+ 2·9	5·42	190·0
8	−13·37	−27·5	+ 2·25	+180·0
9	−10·82	−53·4	− 0·93	+168·9
10	− 6·60	−71·0	4·09	156·7
11	− 1·39	−77·8	7·22	143·6
12	+ 4·02	−73·3	10·30	129·6
13	+ 8·84	−58·4	13·30	114·8
14	+12·39	−35·3	16·21	99·3
15	+14·19	− 7·2	19·01	83·3
16	+13·93	+21·8	21·68	66·7
17	+11·62	+47·5	24·21	49·7
18	+ 7·55	+65·8	26·56	32·5
19	+ 2·31	+73·8	−28·73	+ 15·1
20	− 3·29	+69·8	−30·71	− 2·3
21	− 8·32	+54·2	32·48	19·7
22	−11·95	+29·7	34·03	37·0
23	−13·57	+ 0·2	35·34	53·9
24	−12·96	−29·2	36·41	70·4
25	−10·28	−53·8	37·23	86·4
26	− 6·01	−70·1	37·79	101·7
27	− 0·86	−75·9	38·09	116·3
28	+ 4·42	−70·6	38·13	130·1

		Titan.		*Iapetus.*	
0h Gr.		α−A	δ−D	α−A	δ−D
		s	″	s	″
1882, Dec.	29	+ 9·04	−55·3	37·91	142·9
	30	+12·38	−32·2	37·42	154·7
	31	+13·95	− 4·7	36·67	165·4
1883, Jan.	1	+13·51	+23·4	−35·67	−174·9
	2	+11·09	+48·0	34·43	183·2
	3	+ 6·98	+65·1	32·95	190·2
	4	+ 1·81	+72·0	31·24	195·8
	5	− 3·64	+67·2	29·33	200·0
	6	− 8·47	+51·3	27·22	202·9
	7	−11·86	+26·9	24·93	204·3
	8	−13·27	− 1·9	22·47	204·3
	9	−12·51	−30·3	19·87	203·0
	10	− 9·75	−53·8	17·14	200·2
	11	− 5·50	−69·0	14·30	196·1
	12	− 0·44	−73·8	11·38	190·6
	13	+ 4·67	−68·0	8·39	183·9
	14	+ 9·10	−52·5	5·35	176·0
	15	+12·23	−29·7	− 2·29	−166·9
	16	+13·62	− 2·7	+ 0·77	−156·8
	17	+13·06	+24·5	3·82	145·7
	18	+10·57	+48·0	6·83	133·6
	19	+ 6·49	+64·1	9·78	120·7
	20	+ 1·41	+70·1	12·66	107·1
	21	− 3·87	+64·8	15·44	92·9
	22	− 8·49	+48·8	18·12	78·1
	23	−11·68	+24·7	20·67	62·9
	24	−12·93	− 3·5	23·08	47·4
	25	−12·06	−31·0	25·34	31·6
	26	− 9·28	−53·5	+27·43	− 15·7
	27	− 5·09	−67·8	+29·35	+ 0·3
	28	− 0·15	−71·9	31·08	16·2
	29	+ 4·79	−65·7	+32·62	+31·9
	30	+ 9·04	−50·2	33·95	47·4
	31	+12·00	−27·7	35·08	62·6
Feb.	1	+13·26	− 1·3	36·00	77·3
	2	+12·61	+25·1	36·70	91·5
	3	+10·12	+47·8	37·18	105·1
	4	+ 6·10	+63·2	37·45	118·1

		Titan.		*Iapetus.*	
0h Gr.		α—A	δ—D	α—A	δ—D
		s	″	s	″
1883, Feb.	5	+ 1·15	+ 68·5	37·50	130·4
	6	− 3·97	+ 62·8	37·34	141·8
	7	− 8·42	+ 46·8	36·96	152·4
	8	− 11·44	+ 23·0	36·37	162·1
	9	− 12·57	− 4·6	35·58	170·9
	10	− 11·65	− 31·3	34·60	178·7
	11	− 8·89	− 53·1	33·42	185·4
	12	− 4·79	− 66·7	32·06	191·0
	13	+ 0·01	− 70·4	30·52	195·6
	14	+ 4·80	− 64·0	28·82	199·1
	15	+ 8·89	− 48·5	26·96	201·4
	16	+ 11·73	− 26·3	24·96	202·6
	17	+ 12·90	− 0·4	22·83	202·7
	18	+ 12·22	+ 25·4	20·57	201·6
	19	+ 9·76	+ 47·5	18·21	199·4
	20	+ 5·82	+ 62·3	15·75	196·1
	21	+ 0·99	+ 67·3	13·21	191·7
	22	− 3·98	+ 61·4	10·61	186·2
	23	− 8·27	+ 45·4	7·96	179·7
	24	− 11·18	+ 21·9	5·27	172·2
	25	− 12·24	− 5·2	+ 2·56	+ 163·7
	26	− 11·31	− 31·4	− 0·16	+ 154·3
	27	− 8·61	− 52·7	2·86	144·0
	28	− 4·60	− 65·8	5·54	133 0
Mar.	1	+ 0·07	− 69·3	8·17	121·2
	2	+ 4·72	− 62·8	10·75	108·7
	3	+ 8·70	− 47·5	13·26	95·6
	4	+ 11·44	− 25·5	15·68	82·0
	5	+ 12·57	0·0	18·00	67·9
	6	+ 11·90	+ 25·5	20·20	53·5
	7	+ 9·49	+ 47·2	22·27	38·8
	8	+ 5·65	+ 61·6	24·20	23·9
	9	+ 0·94	+ 66·4	− 25·97	+ 8·9
	10	− 3·91	+ 60·4	− 27·58	− 6·2
	11	− 8·09	+ 44·5	29·01	21·1
	12	− 10·93	+ 21·3	30·25	35·8
	13	− 11·96	− 5·5	31·30	50·3
	14	− 11·10	− 31·4	32·14	64·5

0^h Gr.		*Titan.* α−A	δ−D	*Iapetus.* α−A	δ−D
		s	″	s	″
1883, Mar.	15	− 8·42	−52·3	32·78	78·2
	16	− 4·52	−65·3	33·21	91·3
	17	+ 0·04	−68·7	33·42	103·9
	18	+ 4·59	−62·2	33·42	115·6
	19	+ 8·47	−47·0	33·19	126·7
	20	+11·18	−25·2	32·76	136·9
	21	+12·29	+ 0·1	32·11	146·1
	22	+11·65	+25·3	31·25	154·4
	23	+ 9·31	+46·8	30·19	161·7
	24	+ 5·56	+61·2	28·94	167·9
	25	+ 0·95	+66·0	27·50	173·0
	26	− 3·79	+60·0	25·88	176·9
	27	− 7·90	+44·2	24·10	179·7
	28	−10·70	+21·1	22·17	181·3
	29	−11·74	− 5·5	20·10	181·7
	30	−10·88	−31·3	−17·90	−181·0

Observations of Comet a 1882. By E. J. Stone, Esq.

The following is the series of observations of Comet *a*, 1882, made with the Transit-Circle of the Radcliffe Observatory, Oxford, when passing *sub polo*:—

Ref.	Day.	G.M.T.	Observed R.A.	Observed N.P.D. (uncorrected for Parallax)	Obs.
	1882	h m s	h m s	° ′ ″	
(*a*)	May 12	8 57 20·13	0 14 22·90	15 32 53·4	R.
(*b*)	13	9 18 33·31	0 39 36·12	15 54 2·8	W.
(*c*)	15	9 57 21·31	1 26 23·60	17 8 33·7	R.
(*d*)	16	10 14 15·71	1 47 17·34	18 0 13·6	W.
(*e*)	17	10 29 20·28	2 6 20·93	19 0 10·4	R.
(*f*)	18	10 42 34·30	2 23 33·69	20 7 31·6	W.
(*g*)	19	10 54 4·86	2 39 2·69	21 21 18·6	R.
(*h*)	20	11 3 59·82	2 52 55·84	22 40 44·1	W.
(*i*)	21	11 12 28	3 5(21·75)	24 5(18)	R.
(*j*)	22	11 19 38·44	3 16 30·14	25 33(54)	R.
(*k*)	24	11 30 41·92	3 35 28·55	28 42 28·8	R.
(*l*)	25	11 35 0	—	30 21 48·0	F.B.
(*m*)	26	11 38 14·07	3 50 55·05	32 4 1·2	R.
(*n*)	27	11 40 54·82	3 57 32·80	33 49 7·1	W.
(*o*)	29	11 44 34·11	4 9 5·80	37 27 44·1	R.
(*p*)	31	11 46 21·43	4 18 46·53	41 18 26·7	R.

Observers' Notes:—

(*a*), (*b*) Very faint, but observations fair. (*c*) Very faint at times; observation fair on the whole. (*d*) Nucleus sometimes showed as a bright point, but generally not well defined, and would scarcely stand any illumination of field. Observation, though difficult, very fair. (*e*) Observation good. (*f*) Observation considered very good. Nucleus very sharp at times. (*g*) Difficult, but considered fairly good. Nucleus faint at times. (*h*) Faint. Observation good. (*i*) Observation only approximate. Sky cloudy. (*j*) R.A. good. N.P.D. very rough from a single bisection when extremely faint.

General Notes (*a*) to (*j*).—In the telescope, the light of the head on the night of May 18, the nucleus being better defined than on any other night when the observations were made by me, was certainly not brighter than an eighth magnitude star (W.)

Brightness = Eight in star-magnitude (R.) May 21 and 22, cloudy.

(*k*) Difficult observation, but considered fairly good. Clouds passing. $7\frac{1}{2}$ star-magnitude.

(*l*) The comet was as bright as a 7 or $7\frac{1}{2}$ magnitude star, but cloud prevailed nearly the whole time of the transit: only one bisection made.

(*m*) Observation pretty good. As bright (in telescope) as a 7–6 mag. star.

(*n*) Observation very satisfactory. Nucleus a bright point equal to $6\frac{1}{3}$ star-magnitude.

(*o*) Observation good. Brightness in star-magnitude = 6–5. *Note.*—May 29, 13^h. The comet and tail are both visible with the naked eye.

(*p*) Very good observation. Brightness in telescope = $4\frac{1}{2}$ mag. *Note* at $10\frac{1}{2}^h$.—Compared comet with stars near for magnitude, and found it (to the naked eye) identical in brightness with δ Persei = 3rd magnitude. Observers—W. = Mr. Wickham. R. = Mr. Robinson. F.B. = Mr. F. Bellamy.

Observation of Comet a 1882. By L. G. Puckle, Esq.

(*Communicated by Capt. H. Toynbee, R.N.*)

On Friday, June 23, at $7^h\ 20^m$ P.M., the ship being in latitude 2° 30′ N., and longitude 104° 33′ E., we observed a large comet a little to the southward of the planet *Venus*.

The following angles were observed with a sextant:—

	°	′	″
Altitude of *Venus*	13	30	0
Altitude of nucleus of comet ...	12	0	0
Angle between nucleus and *Venus* ...	6	30	0

The nucleus was well defined and bright, like a star of the second magnitude, the tail spreading out like a fan to the extent of about two and a half degrees of altitude, as visible with the naked eye. The tail stretched upwards from the horizon, with a slight curve in it towards the southward, at the upper end.

The comet remained visible until it sank behind the clouds on the horizon. Careful search was made for it the next night, but without success. We did not see it again, even with the aid of a telescope.

On our arrival at Hong Kong on June 30 we made inquiries about it, but found that nobody had seen it or heard anything about it until we ourselves reported it.

The Solar Eclipse of 1882, *May* 17, *observed at Vizagapatam.* By A. V. Nursinga Row, Esq.

The partial eclipse of the Sun of 1882, May 17, was observed at the Observatory, Daba Gardens, Vizagapatam (Latitude 17° 42′ 9″ N., Longitude $5^h\ 33^m\ 32^s{\cdot}3$ E., according to the Trigonometrical Survey). There were no clouds, but the sky was hazy, and the Sun was surrounded by a halo during the whole time of the eclipse. The beginning of the eclipse was observed by observer Verabadroodoo at local sidereal time $4^h\ 25^m\ 17^s$; the end was observed by Mr. A. V. Juggarow at local sidereal time $6^h\ 57^m\ 21^s$.

On the Solution of Kepler's Problem. By Prof. Ch. V. Zenger.

The various modes of calculating the true anomaly by means of the mean anomaly and eccentricity of the planetary orbit considered by Mädler, Leverrier, and J. W. L. Glaisher, require a considerable amount of calculation, partly owing to the slow convergence of the series employed.

Writing

$$E - e \sin E = F = m\,(T - t),$$

where E denotes the true anomaly, e the eccentricity, m the mean anomaly, and T the time of perihelion, in the following manner—

$$E - F = e \sin E,$$

it becomes obvious, from the small amount of the eccentricity, that E−F will be always small, and the series will rapidly converge.

Now

$$E - F = \sin(E-F) + \frac{1}{6}\sin^3(E-F) + \frac{3}{40}\sin^5(E-F) + \frac{15}{336}\sin^7(E-F) + \text{ \&c.};$$

and we thus have

$$\frac{\sin(E-F)}{\sin E} = \frac{e}{1 + \frac{1}{6}\sin^2(E-F) + \frac{3}{40}\sin^4(E-F) + \frac{15}{336}\sin^6(E-F) + \ldots}$$

and therefore

$$\cot F - \cot E = \frac{e \operatorname{cosec} F}{1 + \frac{1}{6}\sin^2(E-F) + \frac{3}{40}\sin^4(E-F) + \frac{15}{336}\sin^6(E-F)}.$$

For the first approximation E−F may be replaced by its maximum value, viz.

$$E - F = ew \sin 90^\circ = ew,$$

where *ew* is the angular value of the eccentricity; the first approximation thus is

$$\cot E = \cot F - \frac{e \operatorname{cosec} F}{1 + \frac{1}{6}\sin^2 ew + \frac{3}{40}\sin^4 ew + \frac{15}{336}\sin^6 ew}.$$

The value thus obtained gives the angular difference

$$E - F = e \sin E.$$

We have also

$$dE = \frac{dF}{1 - e\cos E},$$

and correcting by the known variation of E, we get immediately with the first approximation, a value correct to the seconds, as the following parallel calculations of the true anomaly of *Mars* by Mädler's and the present method show, without the application of the *regula falsi*.

Mädler's method.—Suppose the true anomaly of *Mars* required for

$$\text{April } 24,\ 13^h\ 25^m\ 15^s{\cdot}0,$$

$$\begin{array}{rr} T = \text{Jan. } 8, & 9^h\ 44^m\ 0^s{\cdot}0 \\ T - t = & 107,\ 3^h\ 41^m\ 15^s{\cdot}0 \end{array},$$

$$m = \frac{360^\circ}{686{\cdot}97964} = 0^\circ\ 31'\ 26''{\cdot}516,$$

$$m\,(T-t) = F = 56^\circ\ 9'\ 7''{\cdot}4,\ e = 0{\cdot}0932168,$$

$$ew = 19227''{\cdot}24 = 5^\circ\ 20'\ 27''{\cdot}04.$$

Mädler says the value of E must be comprised between 59° 9′·12 and 61° 29′·55, and puts E=60° for the first approximation,

$$\log \sin 60^\circ = 9{\cdot}9375306,$$

$$\log ew = \frac{4{\cdot}2839195}{4{\cdot}2214501} = \log 16651''{\cdot}53,$$

$$E - ew \sin E = 60^\circ - 4^\circ\ 37'\ 31''{\cdot}33 = 56^\circ\ 22'\ 28''{\cdot}67,$$

$$\begin{array}{rr} F = & 56^\circ\ 9'\ 7''{\cdot}40 \\ dF = - & 0^\circ\ 46'\ 38''{\cdot}73 \end{array}.$$

For comparison, I now give the first approximation obtained by my own method.

$$\cot E = 0{\cdot}670645 - \frac{0{\cdot}112243}{1 + \frac{\sin^2(5^\circ\ 20'{\cdot}45)}{6} + \frac{3\sin^4(5^\circ\ 20'\ 45)}{40}},$$

$$\cot E = 0{\cdot}670645 - \frac{0{\cdot}112243}{1{\cdot}01448} = 0{\cdot}670645 - 0{\cdot}110390,$$

$$\cot E = 0{\cdot}560255,\ E = 60^\circ\ 45'\ 36'',$$

$$\log \sin 60^\circ\ 45'\ 36'' = 9{\cdot}94079,\ F' = ew = 4^\circ\ 39'\ 35''{\cdot}6,$$

$$\log ew = \underline{4{\cdot}28392}$$

$$4{\cdot}22471 = \log 16775''{\cdot}6,$$

$$E - F' = 60^\circ\ 45'\ 36''{\cdot}0 - 4^\circ\ 39'\ 35''{\cdot}6 = 56^\circ\ 6'\ 0''{\cdot}4,$$

$$F = 56^\circ\ 9'\ 7''{\cdot}4$$

$$\Delta F' = 0^\circ\ 3'\ 7''{\cdot}0$$

$$\Delta F : \Delta F' = 46'{\cdot}645 : 3'{\cdot}12 = 15 : 1.$$

The first approximation by my own method is fifteen times better than Mädler's result.

But using the differential relation

$$dE = \frac{187''}{1 - 0{\cdot}09322\cos 60^\circ\ 45'{\cdot}6} = 195''{\cdot}92,$$

the corrected true anomaly will be

$$E + \delta E = E_1 = 60^\circ\ 45'\ 36''{\cdot}0 + 3'\ 15''{\cdot}92,$$

$$E_1 = 60\ 48\ 51{\cdot}92.$$

Mädler has to go through three approximative calculations to find finally the true anomaly

$$E = 60^\circ\ 48'\ 53''{\cdot}78,$$

giving an error

$$\Delta F = 0\ \ 0\ \ 0{\cdot}04.$$

It is obvious how rapidly the proposed method, using only one approximation, gives to $1''{\cdot}80$ the true value of E.

The next approximation would bring the value of E to

$$60^\circ\ 48'\ 53''{\cdot}72.$$

Prague:
1882, *July* 17.

Postscript.

The largest planetary eccentricity not exceeding 0·4, it will in all cases be sufficient to take the two first terms of powers of sin (E − F), which may be replaced for the first approximation by

$$\theta_0 = 1 + \frac{1}{6}\sin^2(ew) + \frac{3}{40}\sin^4(ew).$$

It will greatly shorten computation if θ_0 be given by a small table for the eight principal planets.

The following table gives for those planets the terms $\log \theta_0$ and $\log \frac{e}{\theta_0}$:

I. $\log \theta_0$ and $\log \left(\frac{e}{\theta_0}\right)$.

	e	ew	θ_0	$\log \theta_0$	$\log \frac{e}{\theta_0}$	$\log e$
☿	0·2056048	11° 46′ 55″·89	1·082021	0·0342357	9·2787978	9·3130335
♀	0·0068433	0 23 31·53	1·000008	0·0000037	7·8352619	7·8352656
♁	0·0167701	0 57 39·08	1·000047	0·0002041	8·2243316	8·2245357
♂	0·0932611	6 43 41·21	1·002288	0·0009882	8·9687025	8·9697007
♃	0·0482388	2 45 49·97	1·000388	0·0001685	8·6832281	8·6833966
♄	0·0559956	2 55 49·92	1·000436	0·0001893	8·7479645	8·7481538
♅	0·0465775	2 40 7·30	1·000361	0·0001568	8·6680194	8·6681762
♆	0·0087195	0 29 48·53	1·000013	0·0000054	7·9404862	7·9404916

The first approximation may be immediately obtained by the equation

$$\log (\cot F - \cot E_0) = \log\left(\frac{e}{\theta_0}\right) + \log \operatorname{cosec} F = \log\left(\frac{e}{\theta_0}\right) - \log \sin F.$$

Let the number to the 6th decimal be N, and we get

$$\cot E_0 = -N + \cot F.$$

Computing now with the value E_0, that of F_0, $\delta F = F - F_0$, becomes a known value, and by means of Table II. the correction of E is directly obtained by the equation

$$\log \delta E = \log \delta F + \log (1 - e \cos E)^{-1} = \log \delta F + \log (1 + e \cos E).$$

II. $\log (1 - e \cos E)^{-1}$.

E=	10°	20°	30°	40°	50°	60°	70°	80°	90°
☿	0·09826	0·09323	0·08197	0·07443	0·06157	0·04711	0·03166	0·01579	0·00000
♀	0·00293	0·00280	0·00257	0·00228	0·00192	0·00148	0·00101	0·00052	0·00000
♁	0·00723	0·00690	0·00635	0·00562	0·00471	0·00366	0·00250	0·00126	0·00000
♂	0·05317	0·05659	0·04639	0·04079	0·03396	0·02619	0·01816	0·00891	0·00000
♃	0·02112	0·02014	0·01852	0·01634	0·01368	0·01060	0·00723	0·00365	0·00000
♄	0·02463	0·02347	0·02158	0·01904	0·01589	0·01232	0·00840	0·00424	0·00000
♅	0·02040	0·01944	0·01787	0·01628	0·01320	0·01023	0·00748	0·00353	0·00000
♆	0·00375	0·00371	0·00329	0·00292	0·00362	0·00190	0·00129	0·00066	0·00000

Réponse à M. Marth. Par M. Loewy.

(*Communicated by Mr. Stone.*)

Dans la réunion du mois de Mai dernier, M. Marth a fait à la Société Royale Astronomique une nouvelle communication relative à la détermination des flexions, et dans cette note il prétend avoir rencontré dans mes écrits quelques assertions extraordinaires, et il s'applique à les combattre avec énergie.

J'ai lu attentivement et à plusieurs reprises le Mémoire de M. Marth, et, par surcroît de précaution, j'ai prié quelques-uns de mes amis de le lire et de le comparer avec ce que j'ai publié moi-même, pour voir s'ils seraient plus capables que moi de retrouver quelque chose qui ait pu donner lieu à M. Marth de m'attribuer les assertions singulières qu'il combat si victorieusement; et si, d'un autre côté, M. Marth répond à une seule des objections que j'ai faites contre les nombreux inconvénients résultant de l'emploi de son appareil.

En vérité, M. Marth ne répond à aucune de mes objections, et il se contente de démontrer, avec beaucoup de sagacité, du reste, que le centre optique ne se déplace pas lorsque l'objectif oscille légèrement autour de ce centre; c'est là un théorème d'optique élémentaire bien connu qui d'ailleurs n'avait rien à faire dans la question qui nous occupe actuellement.

Dans mon Mémoire, j'ai indiqué (pages 9 à 18, et 56 à 62), en exposant la théorie de mon appareil, tous les mouvements que peut subir la lentille auxiliaire pendant la rotation de la lunette, et j'ai mis en équation seulement ceux qui sont de nature à produire un déplacement du centre optique en excluant tous les autres, et j'ai naturellement compris dans cette exclusion tous les mouvements oscillatoires autour du centre optique.

Je me suis dispensé de donner à propos de chacun de ces mouvements une démonstration quelconque, car je supposais chez mes lecteurs non seulement quelques notions d'optique élémentaire, mais même des connaissances en optique supérieure. Peut-être M. Marth a-t-il, bien involontairement sans doute, omis de lire les pages notées ci-dessus, ou peut-être, cédant à l'entraînement d'une imagination un peu prévenue, a-t-il cru trouver les assertions singulières qu'il combat si victorieusement, mais dont, malheureusement pour lui, on ne trouve aucune trace dans la note que j'ai eu l'honneur de soumettre à la Société Royale Astronomique. Et d'autre part, comme je viens de le dire, j'ai précisément indiqué dans le Mémoire sur la Flexion le contraire des assertions que me prête M. Marth.

Quoiqu'il en soit, je vais, pour terminer cette discussion, exposer de nouveau avec quelques détails les déplacements que peut subir pendant la rotation, quand il s'agit par exemple de la flexion en hauteur, une lentille introduite dans le cube central de la lunette.

Il peut se produire :

1° Un déplacement de l'objectif dans son ensemble et perpendiculairement à l'axe optique par suite du mode d'attache de l'appareil au cube.

2° Un glissement également perpendiculaire à l'axe optique de l'un des verres par rapport à l'autre.

3° Une sorte de déplacement ou d'écartement angulaire des verres de l'objectif.

4° Des déformations dues aux mouvements 2 et 3 ou à des flexions différentes subies par les verres pendant la rotation.

Les mouvements 1 et 2 provoquent naturellement un déplacement direct de la ligne de visée.

Le mouvement 3, quoique ne provoquant pas le déplacement matériel du centre optique, altère les images dans le réticule pendant la rotation de la lunette. Le mouvement 2 peut provoquer également une déformation.

Ces déplacements ou ces altérations sont parfois assez notables et peuvent faire naître des erreurs systématiques ; il y a toujours lieu d'en tenir compte, surtout quand il s'agit de déterminer la variation de la ligne de visée avec la plus haute précision : c'est-à-dire à quelques centièmes près de seconde d'arc.

C'est un fait maintenant bien connu que dans beaucoup de lunettes, et surtout dans la plupart des petits instruments, la véritable flexion n'existe pas, et qu'en réalité les variations qu'on y rencontre souvent sont produites ou par de légers déplacements de la monture portant l'objectif ou par les mouvements 2 et 3 dans la monture.

Pendant plusieurs années ces causes ont provoqué une variation de la ligne de visée à la lunette de Gambey, à l'Observatoire de Paris. Le même fait existe au petit cercle méridien de Brunner installé à l'Observatoire de Montsouris (*Mémoires du Bureau des Longitudes*, tome i.). Lors de nos opérations de longitude entre Paris et Brégentz, nous avons, M. Oppolzer et moi, constaté un effet analogue avec l'instrument sortant des ateliers de MM. Troughton et Simms. Plus tard dans les déterminations de différences de longitude entre Paris et Berlin, nous avons trouvé une variation très-notable dans la ligne de visée, à la lunette de Rigaud, et pour la faire disparaître il nous a fallu démonter et remonter à nouveau l'objectif de ce petit instrument (*Mémoires du Bureau des Longitudes*, tome ii., qui va paraître prochainement). Et la valeur numérique des variations de la ligne de visée dans ces divers instruments est comprise entre 1″ et 3″.

Il faudrait plusieurs pages pour faire la liste de tous les instruments dans lesquels on a pu constater des déplacements de la ligne de visée, par suite des mouvements 1 ou 2 de l'objectif, et d'ailleurs c'est un fait bien connu de tous les astronomes qui ont étudié avec soin leurs lunettes.

En dehors de ces déplacements directs des images dans le réticule, on se trouve parfois en présence, comme nous l'avons indiqué plus haut, de déformations pouvant causer de légères

erreurs systématiques ; il est donc inadmissible pour évaluer ces effets dans la détermination de la variation de la ligne de visée d'employer un appareil qui peut provoquer des erreurs analogues plus considérables encore.

Déjà en 1859, M. Prazmowski en faisant à l'observatoire de Varsovie ses observations méridiennes avec une lunette de 4 pouces, construite par Frauenhofer, a été frappé de la déformation qui se produisait dans les images pendant la rotation, et reconnut que cette déformation qui donnait lieu à des erreurs sensibles dans les observations tenait au décentrage ; c'est alors qu'il fit construire un appareil spécial pour mieux évaluer la nature et l'étendue de la déformation correspondant à chacun des mouvements 2 ou 3. J'ai eu moi-même, en ces derniers temps, l'occasion de constater le même fait, en examinant les qualités optiques de plusieurs instruments destinés à l'observation du prochain passage de *Vénus*.

En variant la position de la lunette, les anneaux de diffraction se déformaient sensiblement, et de circulaires devenaient elliptiques et quelquefois absolument irréguliers. Ces déformations étaient même si considérables que nous étions tout d'abord tentés de les attribuer à un défaut de construction, mais une autre position de la lunette les augmentait ou parfois les faisait disparaître, de sorte qu'on ne pouvait imputer ces altérations des images qu'à un déplacement de l'un des verres de l'objectif, à un effet de décentrage ou de flexion.

Des mouvements encore plus dangereux peuvent se manifester lorsqu'on introduit dans le cube de la lunette un miroir.

Mais, en résumé, qu'il s'agisse d'un déplacement direct de la ligne de visée ou d'une déformation des images, on ne peut *a priori* affirmer qu'elles n'existeront pas, quelles que soient l'habileté du constructeur et la perfection de l'instrument. C'est l'expérience seule qui plus tard peut les faire trouver.

Tous ces faits si connus des astronomes au courant des études de haute précision, m'ont engagé à réunir sur un seul disque de verre toutes les pièces nécessaires à mon appareil, et pour le rendre invariable dans sa monture et absolument indéformable pendant la rotation de la lunette, j'ai déterminé par des expériences directes l'épaisseur qu'il fallait donner à ce bloc de verre pour pouvoir le coller dans sa monture, le serrer même à force dans son barillet sans l'exposer à éprouver d'altération ou de déformation sensible. Cette épaisseur égale à 0·25 du diamètre permet d'obtenir ce résultat qu'on ne saurait atteindre avec des valeurs inférieures.

En rendant ainsi toutes les déformations impossibles j'ai pu par une expérimentation rigoureuse déterminer tous les mouvements de translation et de rotation du seul disque de verre qui constitue mon appareil.

On voit par tout ce qui précède la multiplicité des déplacements auxquels peut donner lieu l'appareil de M. Marth composé de cinq pièces optiques disposées de telle façon que

l'image doit traverser deux objectifs ou deux fois le même objectif et un miroir. Les déformations des images ou leurs déplacements deviennent alors si nombreux et si considérables qu'il n'y a aucune méthode possible pour les éviter ou les évaluer. C'est ce qui explique pourquoi cet appareil est depuis vingt ans demeuré sans application possible.

Je n'ai plus rien à ajouter sur les nouvelles explications que fournit M. Marth dans la note du mois de Mai; il y donne lui-même la réfutation la plus complète de son appareil; il nie *a priori* les mouvements même les plus probables, et donne pour ceux qu'il veut bien admettre des méthodes d'évaluation tout à fait défectueuses.

Je ne doute pas que M. Marth ne présente son appareil à la Société Royale Astronomique, mais ce dont je doute énormément, c'est qu'il puisse apporter à l'appui une série d'expérimentations donnant des résultats précis, et concordant avec les valeurs trouvées par les procédés astronomiques connus.

Je ne crois pas devoir continuer la discussion sur cette matière. Aujourd'hui, il sera facile aux astronomes de trouver dans les notes et Mémoires publiés des deux côtés tous les éléments nécessaires pour asseoir leur jugement avec facilité et sécurité. Je ne répondrai même plus à M. Marth s'il lui vient encore à l'esprit de m'accuser de quelque nouvelle hérésie relative à une question de mécanique ou de géométrie élémentaires.

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